[English Translation of Excerpt from Reference 1]

Laid-Open Japanese Utility Model Application S63-036862 U
Laid-Open Date: March 09, Year of Showa-63 (1988)
Title of Device: CAPILLARY PUMPLED LOOP
Japanese Utility Model Application S61-131724
Filing Date: August 28, Year of Showa-61 (1986)
Device Creator: Kiyoshi TANAKA [JP]
Applicant: NEC Corp. [JP]

[Claim]

A capillary pumped loop comprising an evaporator for introducing a working fluid from a working fluid inlet, heating the same for evaporation, and withdrawing vapor thereof from a vapor outlet, a condenser for introducing the vapor of said working fluid from a vapor inlet, cooling the same for condensation and withdrawing thus condensed working fluid from a working fluid outlet, a vapor line for providing communication between said working fluid outlet of said condenser and said working fluid inlet of said evaporator, wherein a no-return valve is disposed at said vapor outlet of said evaporator and at said vapor inlet of said condenser respectively along the direction to prevent the reverse flow of vapor.

[Brief Explanation of Figures]

Figure 1 is a conceptual figure showing the constitution of an example for the present device, and Figure 2 is a conceptual figure showing the constitution of a capillary pumped loop according to the prior art.

[Explanation of Codes]

(1a, 1b, 1c) No-return valve; (2a, 2b) Evaporator; (3a, 3b) Wick; (4) Vapor; (5) Working fluid; (6) Reservoir; (7) Separated vapor; (8) Condenser; (9) Vapor line; and (10) Liquid line.

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⑲日本国特許庁（JP）　⑪実用新案出願公開

⑫公開実用新案公報（U）　昭63－36862

⑤1Int.Cl.⁴	識別記号	庁内整理番号	⑬公開 昭和63年(1988)3月9日
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審査請求 未請求 （全 頁）

⑤4考案の名称　キャピラリポンプループ

⑳実　願　昭61－131724
㉒出　願　昭61(1986)8月28日

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明　細　書

1．考案の名称

キャピラリポンプループ

2．実用新案登録請求の範囲

作動液を作動液取入れ口から取り入れてこれを加熱して蒸発させこの蒸気を蒸気取出し口から取り出す蒸発器と、前記作動液の蒸気を蒸気取入れ口から取り入れてこれを冷却して凝縮させ凝縮した作動液を作動液取出し口から取り出す凝縮器と、前記蒸発器の前記蒸気取出し口と前記凝縮器の前記蒸気取入れ口を結ぶ蒸気流路と、前記凝結器の前記作動液取出し口と前記蒸発器の前記作動液取入れ口を結ぶ作動液流路からなるキャピラリポンプループにおいて、前記蒸発器の前記蒸気取出し口と前記凝縮器の前記蒸気取入れ口にそれぞれ蒸気の逆流を防止する向きに逆止弁を設けたことを特徴とするキャピラリポンプループ。

３．考案の詳細な説明

（産業上の利用分野）

本考案は温度制御素子として用いられるキャピラリポンプループの改良に関する。

（従来の技術およびその問題点）

従来のキャピラリポンプループは第２図のように構成されている。作動液５は蒸発器２ａ，２ｂに入って加熱されウィック３ａ，３ｂから蒸発し、蒸気４は蒸気流路９を通って凝縮器８に至りここで熱を放出して凝縮し液体に戻る。液体に戻った作動液５は液体流路１０を通って蒸発器２ａ，２ｂに戻る。蒸発器２ａ，２ｂへ入る作動液５に蒸気が混入していると蒸発器の吸熱効率が低下するので、作動液５のタンクであるリザーバ６に気液分離機能を与えて作動液中に混入した蒸気７を分離して取除いている。作動液５とその蒸気４のこのような循環に伴い、蒸発器２ａ，２ｂで熱は蒸気４に吸収されて凝縮器８へ移送されここで放出される。吸熱量と発熱量を大きくするために作動液には気化潜熱の大きい液化フレオンあるいは液

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化アンモニアなどが用いられる。このように、蒸発器２ａ，２ｂでは吸熱が行われ、凝縮器８では放熱が行われるから蒸発器を機器の内部に収め、凝縮器を外部に置けば、熱を機器の内部から外部へ放出できる。反対に、機器の内部に凝縮器を外部に蒸発器を置けば外部から機器の内部へ熱を取り込むことができる。第２図のように蒸発器を複数個用いて構成したキャピラリポンプを機器の放熱に使用すると、それぞれの蒸発器の周辺にある機器の発熱量の差によって、各蒸発器間に温度差が生じる。その温度差によって、各蒸発器間の蒸気発生量および蒸気圧のバランスが失われ、蒸気は圧力の高い蒸発器から低い蒸発器に向かって流れ込む。蒸気が逆流するとその蒸発器においては作動液の蒸発・吸熱のプロセスが定常状態から逸脱しコントロールすることができなくなる。また、このキャピラリポンプを人工衛星の温度制御素子として用いると、打上げに伴う振動や衝撃あるいは宇宙空間の無重力などの影響で作動液５が凝縮器８の蒸気取入れ口から蒸気流路９へ侵入するこ

とがある。すると蒸発器２ａ，２ｂ、液体流路１０、凝縮器８中の作動液５には蒸気流路９に洩れ出した作動液５の体積分の真空の気泡が発生し液中に分散する。この気泡は水銀温度計の銀切れに相当するものであるが、このようなことが生じると蒸発器において作動液の循環が途切れてしまいキャピラリポンプが始動不能になる。

本考案の目的は、上に記したような欠点のないキャピラリポンプループを提供することにある。

（問題点を解決するための手段）

本考案のキャピラリポンプループは、第１図に示すように、作動液を作動液取入れ口から取り入れてこれを加熱して蒸発させこの蒸気を蒸気取出し口から取り出す蒸発器と、前記作動液の蒸気を蒸気取入り口から取り入れてこれを冷却して凝縮させ凝縮した作動液を作動液取出し口から取り出す凝縮器と、前記蒸発器の前記蒸気取出し口と前記凝縮器の前記蒸気取入れ口を結ぶ蒸気流路と、前記凝結器の前記作動液取出し口と前記蒸発器の前記作動液取入れ口を結ぶ作動液流路からなるキ

ャピラリポンプループにおいて、前記蒸発器の前記蒸気取出し口と前記凝縮器の前記蒸気取入れ口にそれぞれ蒸気の逆流を防止する向きに蒸気の逆流を防止する向きに逆止弁を設けたことを特徴とする。

（実施例）

第１図に本考案のキャピラリポンプループの一実施例を示す。各蒸発器２ａ，２ｂの蒸気取出し口と凝縮器８の蒸気取入れ口の蒸気流路９に逆止弁１ａ，１ｂ，１ｃを設けた。逆止弁はそれぞれ矢印で示した蒸気の流れの逆流を防止する向きに取り付けてある。従って、作動液５とその蒸気４は順方向に循環し、どのような条件下でも逆流することはない。

（考案の効果）

このように、本考案のキャピラリポンプループは、複数個の蒸発器の間に蒸気圧のアンバランスが生じても蒸気の逆流は起こらないから蒸発器がコントロール不能に陥ることはない。また、人工衛星に搭載された場合でも作動液が蒸気相中へ洩

れ出さず従って作動液に気泡は発生しないから始動不能になることはない。

４．図面の簡単な説明

第１図は本考案の一実施例の構成を示す概念図、第２図は従来のキャピラリポンプループの構成を示す概念図である。

１ａ，１ｂ，１ｃ…逆止弁、２ａ，２ｂ…蒸発器、３ａ，３ｂ…ウィック、４…蒸気、５…作動液、６…リザーバ、７…分離蒸気、８…凝縮器、９…蒸気流路、１０…液体流路。

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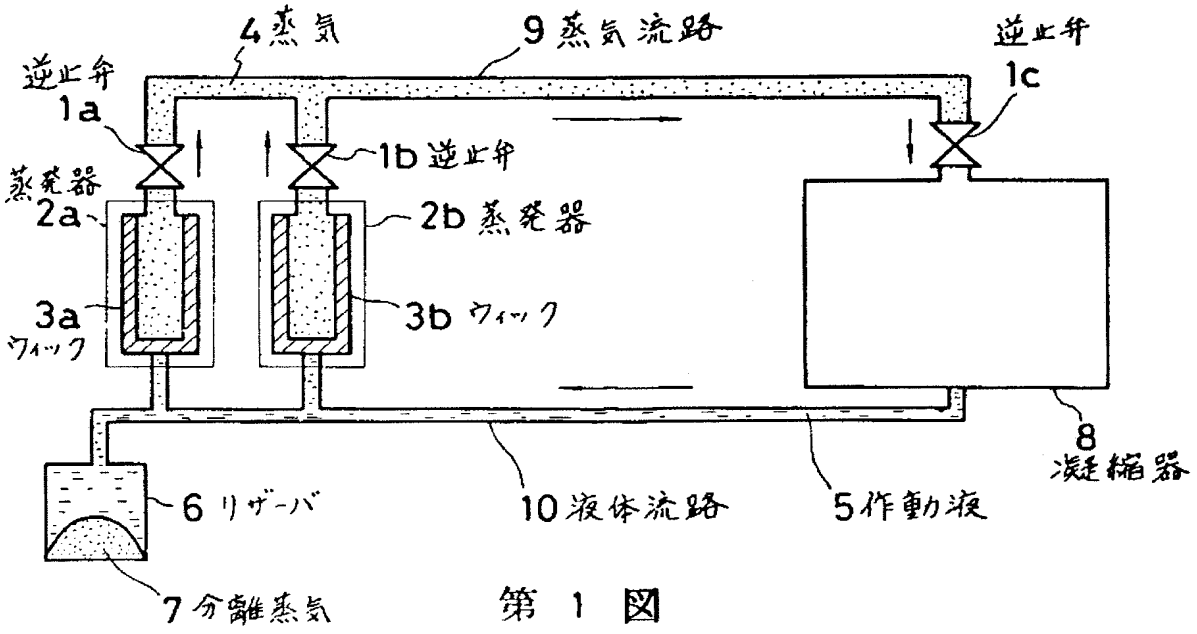
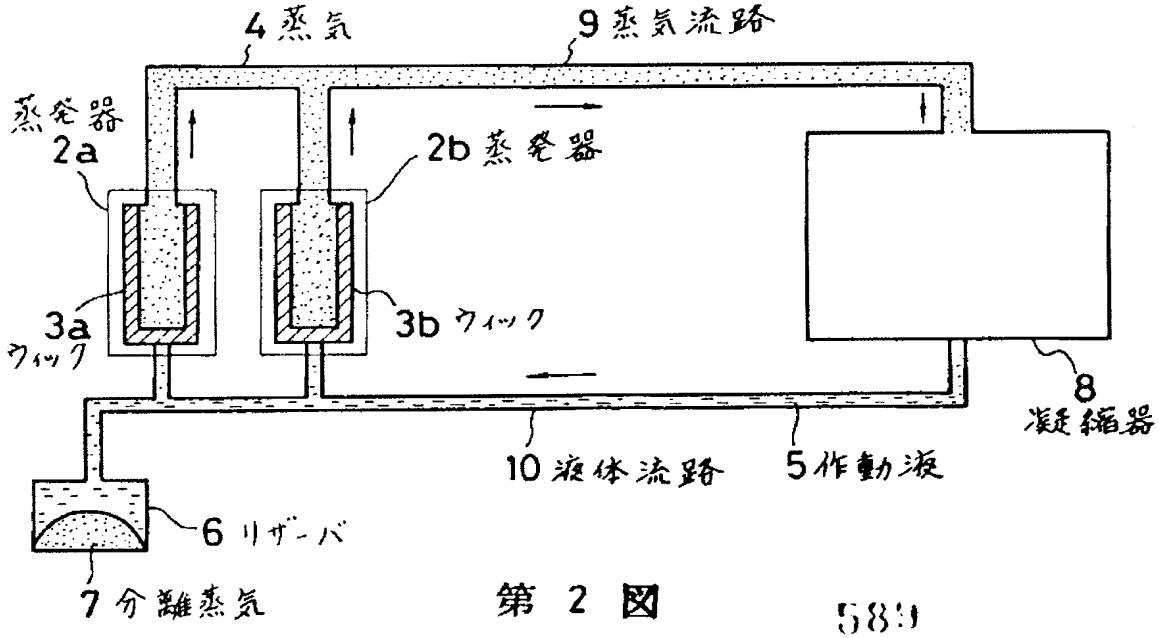


第 1 図



第 2 図

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実開63-

代理人 弁理士 木内伸介

手 続 補 正 書(自発)

昭和 62.2.23 年 月 日

特 許 庁 長 官 殿

1．事件の表示　　昭和61年実用新案登録願第131724号

2．考案の名称　　キャビラリボンプルーブ

3．補正をする者

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5．補正の対象　　明細書の考案の詳細な説明の欄

方式審査

52 2.25

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6．補正の内容

（１）明細書第２ページ第13行目から第16行目に、「吸熱効率が低下するので、作動液５の・・・・・取除いている。」とあるのを、「吸熱効率が低下する。作動液５のタンクであるリザーバ６には気液分離機能を与えて、蒸発器２ａ，２ｂでの発熱変動および凝縮能力の変動があってもキャピラリポンプループ内の圧力を一定に保ち、飽和温度を一定に制御している。」と補正する。

（２）明細書第５ページ第３行目から第４行目に、「蒸気の逆流を防止する向きに蒸気の逆流を防止する向きに逆止弁を設け」とあるのを、「蒸気の逆流を防止する向きに逆止弁を設け」と訂正する。

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(54) CAPILLARY PUMP LOOP

[Amendment has been incorporated in the translation]

TITLE OF INVENTION

Capillary Pump Loop

CLAIM

Capillary pump loop, characterized in that the capillary pump loop comprises evaporators wherein an operating fluid is brought in from an operating fluid inlet, followed by heating to make it evaporate so that the vapor is let out from a vapor outlet; a condenser wherein the vapor of said operating fluid is brought in from the vapor outlet to be cooled and condensed, and the operating fluid condensed is let out from the operating fluid outlet; a vapor flow channel that connects said vapor outlet of said evaporator to said vapor inlet of said condenser; and an operating fluid flow channel that connects said operating fluid outlet of said condenser to said operating fluid inlet of said evaporator; with check valves being installed at said vapor outlet of said evaporator as well as at said vapor inlet of said condenser in the direction preventing backflow of the vapor.

DETAILED DESCRIPTION OF THE INVENTION

Field of Industrial Application

The present invention pertains to the improvement of a capillary pump loop used as temperature control device.

Prior Arts, and its Problems

The conventional capillary pump loop is configured as seen in Figure 2. Operating fluid 5 enters evaporators 2a, 2b to be heated and vaporized from wicks 3a and 3b. Vapor 4 goes to condenser 8 passing through vapor flow channel 9 to release its heat and undergoes condensation, and it returns to liquid. Operating fluid 5, which has returned to liquid, goes back to evaporators 2a and 2b through liquid flow channel 10. Endothermic efficiency of the evaporator will decrease if vapor became mixed in the operating fluid 5 that entered the evaporators 2a and 2b. A vapor-liquid separation function is provided to the reservoir 6, which is the tank for operating liquid 5. The pressure inside the capillary pump loop will be maintained at constant level and the saturated temperature will be controlled at constant level even if there is variation in heat generation as well as condensation capability. Following such circulation of the operating fluid 5 and its vapor 4, the heat is absorbed at evaporators 2a and 2b to vapor 4, and transferred to condenser 8 to be released here. Liquid freon or liquid ammonia that has large latent heat of vaporization is used as the operating fluid in order to create a large absorption of heat as well as heat generation. In this way, heat is absorbed at evaporators 2a and 2b, and

released at condenser 8, so the heat can be released from inside the apparatus to the outside if the evaporator is housed inside the apparatus and the condenser is installed outside. On the contrary, installing the condenser inside the apparatus, and the evaporator outside, can capture the heat from outside into the inside of the apparatus. As can be seen in Figure 2, using the capillary pump built using several evaporators to release the heat at the apparatus generates temperature differences among evaporators according to the differences in the amount of heat generation of the apparatus present surrounding each evaporator. Depending on its temperature differences, the generation amount of vapor among the evaporators as well as the balance of the vapor pressure will be lost, and the vapor will flow from the evaporator with high pressure to the evaporator with low pressure. When the vapor back-flows, depending on its evaporator, the process of evaporating the operating fluid and absorbing the heat will deviate from the normal condition, and it can no longer be controlled. Moreover, when this capillary pump is used as the temperature control device of a satellite, the operating fluid 5 may invade from the vapor inlet of condenser 8 to the vapor flow channel 9 due to the influence of vibration or impact of the launch. This will generate vacuum bubbles from the bulk portion of the operating fluid 5 that was leaking at the vapor flow channel 9 in the operating fluid 5 at evaporator 2a and 2b, fluid flow channel 10, and condenser 8, and it will disperse in the liquid. These bubbles are equivalent to the silver leakage [sic, possibly referring to mercury leakage] of a mercury thermometer; however, if this type of symptom occurs, the circulation of the operating liquid in the evaporator will be discontinued, making the capillary pump unable to start.

The purpose of the present invention is to provide a capillary pump loop that does not have shortcomings mentioned above.

Means to solve the problems

The capillary pump loop of the present invention is characterized in that, as shown in Figure 1, the capillary pump loop comprises evaporators wherein an operating fluid is brought in from an operating fluid inlet, followed by heating to make it evaporate so that the vapor is let out from a vapor outlet; a condenser wherein the vapor of said operating fluid is brought in from the vapor outlet to be cooled and condensed, and the operating fluid condensed is let out from the operating fluid outlet; a vapor flow channel that connects said vapor outlet of said evaporator to said vapor inlet of said condenser; and an operating fluid flow channel that connects said operating fluid outlet of said condenser to said operating fluid inlet of said evaporator; with check valves being installed at said vapor outlet of said evaporator as well as at said vapor inlet of said condenser in the direction preventing backflow of the vapor.

Application Example

Figure 1 shows an application example of a capillary pump loop of the present invention. Check valves 1a, 1b, and 1c are provided at the vapor outlets of each evaporators 2a and 2b as well as at the vapor flow channel 9 of the vapor inlet of condenser 8. These check valves are installed in the direction preventing the backflow of the vapor as shown with the arrow in the

figure. In this way, operating fluid 5 and its vapor 4 are circulated in the forward direction so that it will not backflow under any circumstances.

Effect of the Invention

In this way, the capillary pump loop of the present invention does not incur a defect where it cannot be controlled because backflow of the vapor will not occur even when the imbalance of vapor pressure occurred among several evaporators. In addition, it will not fail to start because it will not generate bubbles in the operating fluid because the operating fluid does not leak into the vapor phase when it is installed in the satellite.

BRIEF EXPLANATION OF THE FIGURE

Figure 1 is an outline drawing showing the configuration of the application example of the present invention, and Figure 2 is an outline drawing showing the configuration of the conventional capillary pump loop.

1a, 1b, 1c … check valves, 2a, 2b … evaporators, 3a, 3b … wicks, 4 … vapor, 5 … operating fluid, 6 .. reservoir, 7 … separated vapor, 8 … condenser, 9 … vapor flow channel, 10 … fluid flow channel.

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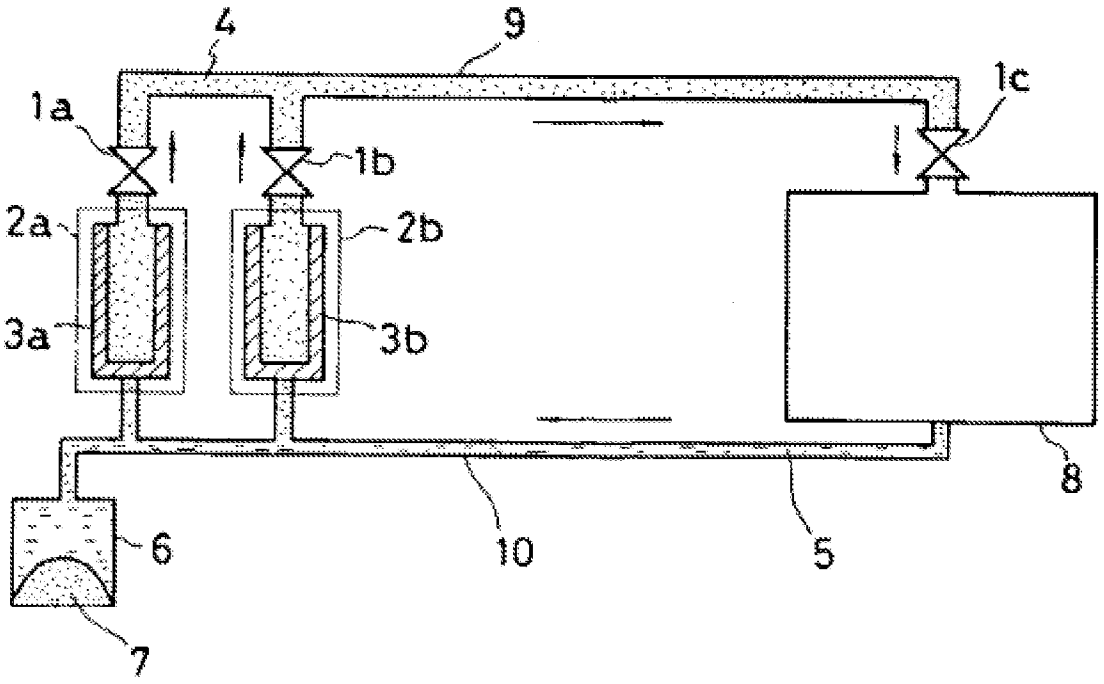

Figure 1

1a, 1b, 1c … check valves, 2a, 2b … evaporators, 3a, 3b … wicks, 4 … vapor, 5 … operating fluid, 6 .. reservoir, 7 … separated vapor, 8 … condenser, 9 … vapor flow channel, 10 … fluid flow channel.

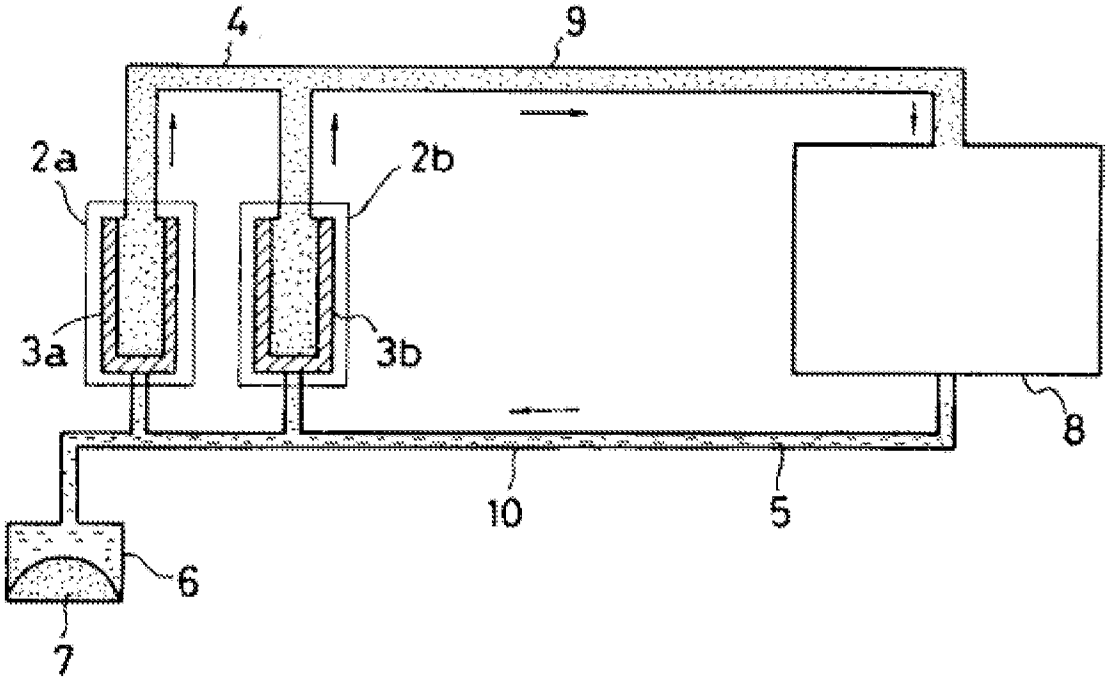

Figure 2

1a, 1b, 1c … check valves, 2a, 2b … evaporators, 3a, 3b … wicks, 4 … vapor, 5 … operating fluid, 6 .. reservoir, 7 … separated vapor, 8 … condenser, 9 … vapor flow channel, 10 … fluid flow channel.